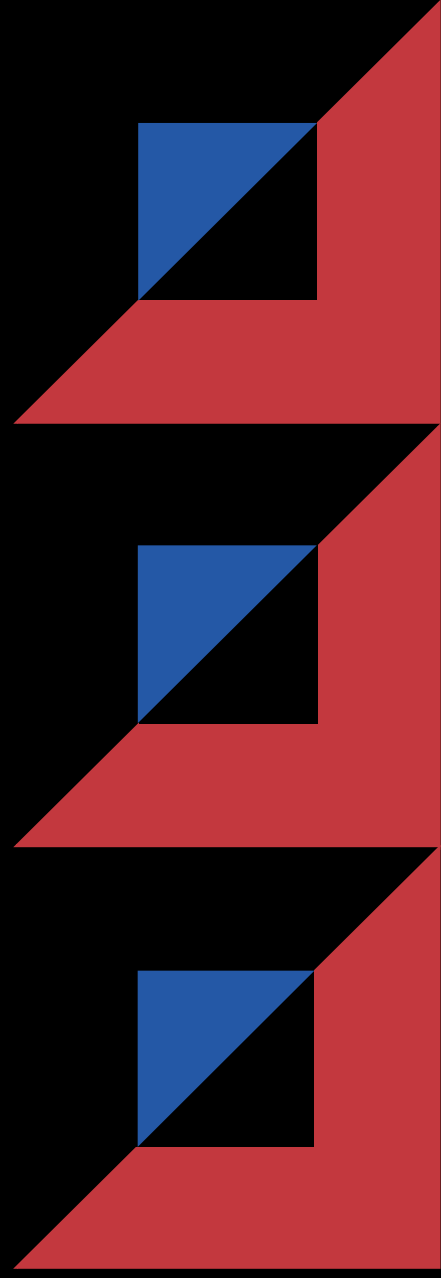

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RECOMMENDATIONS FOR ITS TECHNOLOGY

In Emergency Medical Services

BY THE
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SUBCOMMITTEE
OF THE
ITS AMERICA
PUBLIC SAFETY
ADVISORY GROUP

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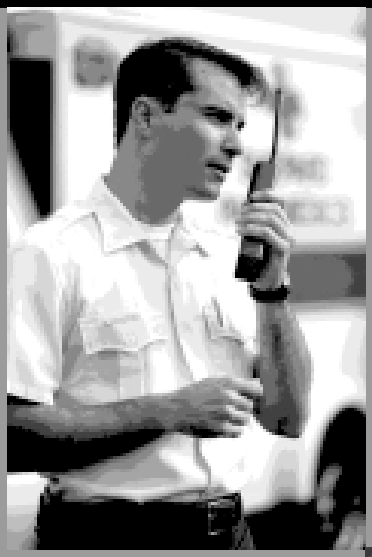


I. Purpose of this Document

This document was developed to provide recommendations regarding future emergency medical service (EMS)-related activities to the U.S. Department of Transportation's (USDOT's) Intelligent Transportation Systems (ITS) Program.

ITS technologies have the potential to provide the nation with more efficient, effective emergency medical services, and safer, more secure highways. But these benefits will not be realized without immediate and substantive input from prospective end-users in the EMS community. This document is intended to provide initial program input, and to encourage the continuing involvement of the emergency medical community in USDOT's ITS program.

The Wireless Technologies/ Telematics Revolution

The EMS community currently is facing serious challenges because new telecommunications and in-vehicle safety technologies have entered the market without sufficient developmental input from EMS physicians and other professionals. For example, the 9-1-1 system, administered through the nation's 7,000 Public Safety Answering Points (PSAPs), faces serious challenges in locating 9-1-1 callers who use wireless telephones. Approximately 130 million Americans now have wireless telephones—up from 76 million in 1999, and just 4.3 million in 1990. The number of subscribers continues to grow at an annual rate of roughly 20 percent.

Prior to the advent of wireless telephones, the PSAPs were able to automatically locate nearly all 9-1-1 callers. Now, more than half of 9-1-1 calls in metropolitan areas cannot be located because they originate from mobile wireless telephones. PSAPs report a rapidly increasing proportion of calls coming from wireless telephones, now averaging about 27 percent nationwide.

Without location capability, 9-1-1 calls from cell phones often compromise public health and safety and result in the inefficient use of EMS resources. Equipment is dispatched to a general area. Rescue crews must search for the incident scene. A common scenario is a crash on a divided-lane freeway, where callers are unable to tell the call-takers the exact location of the incident, or even whether it is in the northbound or southbound (eastbound or westbound) lane. Dispatchers have no choice but to dispatch multiple units, heading in both directions, to search for the incident scene.

ITS technologies have the potential to provide the nation with more efficient, effective emergency medical services, and safer, more secure highways. But these benefits will not be realized without immediate and substantive input from prospective end-users in the EMS community.

Another difficulty is that without location technology, PSAPs have difficulty determining which calls refer to the same incident. PSAPs accepting wireless 9-1-1 calls must handle an astonishing volume of duplicate calls for each incident. One typical metropolitan PSAP receives 80 to 100 calls per car crash, compared to an average of six per crash before it accepted wireless 9-1-1 calls.

Yet another issue is that cell phones have yielded a large increase in unintentional calls to PSAPs. One center estimates that fully one-half of the 130,000 wireless calls it handles each

year are unintentional. Experts attribute the problem to incorrect use of the speed dial feature, or inadvertent dialing due to failure to use a protective phone cover.

In-vehicle telematics systems, including push-button emergency assistance systems (Mayday systems) or automatic emergency assistance systems (automatic collision notification) offer both benefits and challenges to the EMS community. These systems may improve response by providing location information not otherwise available, or by helping to eliminate false alarms. However, they also can create a burden for the PSAP, or delay emergency response, if they require the PSAP to handle more information than needed, or if their input to the PSAPs is delivered through a non-priority line.

As the leaders of the EMS community work with other stakeholders to resolve the issues presented by the introduction of mobile wireless telephones and telematics systems, all involved recognize the need for the EMS community to take a stronger role in new technology development.

The problems surrounding the incorporation of wireless technology into the 9-1-1 system are just one example of an array of potential challenges that new technology presents to public safety operations. The EMS community must be involved long *before* technology is introduced to the marketplace, in order to assure its seamless integration into the existing EMS system. This document is a first step toward the needed EMS community involvement in ITS technology development.

Target Audiences

In addition to USDOT, the document has other equally important audiences.

The authors hope to increase ***EMS community*** awareness of, and involvement in, ITS issues. At the national, state, and local levels, the EMS community has the opportunity to expand the scope of ITS deployment programs to include EMS applications. The EMS community is encouraged to work with the transportation community to integrate emergency incident response operations and communications. Improved integration serves public safety, health, and security, which is a priority for the nation at this time. ITS systems also yield data that can be used for improved information-based EMS policy development and decision-making.

The EMS community must be involved long before technology is introduced to the marketplace, in order to assure its seamless integration into the existing EMS system.

For the ***private sector and industry*** (automobile manufacturers, telematic device manufacturers, telematics service providers, and the telecommunications industry) this document will help to clarify the perspectives and priorities of the emergency medicine community and to guide future product development.

For the ***public sector ITS community*** (state and local transportation agencies), this document is intended to increase awareness of the opportunity to dramatically increase the community value of ITS technology deployment programs by including applications that address EMS and the broader public safety services (fire and rescue, law enforcement, emergency management, etc.).

Origin and Authors

This document was produced by ITS America's Public Safety Advisory Group (PSAG), which includes representatives of the transportation, EMS, law enforcement, fire and rescue, and towing and recovery communities. At its initial meeting in June 2001, the PSAG voted to address the EMS community's perspective on ITS technologies as one of its initial action priorities.

Recommendations for ITS Technology in Emergency Medical Services was written by the PSAG's Medical Subcommittee, chaired by Dr. E. Jackson Allison, Jr., a representative of the American College of Emergency Physicians.

ITS America is a Federal Advisory Committee to the USDOT. The mission of the PSAG is to advise how best to develop and deploy ITS technologies in order to provide the broadest public safety benefits.

II. Background

Intelligent Transportation Systems (ITS) is a term used by the surface transportation community for advanced communications and information systems, including technologies such as mobile wireless voice and data systems, location technologies, road condition sensors, automated traffic signals, changeable message signs, and video surveillance cameras. Surface transportation agencies deploy ITS technologies to improve the efficiency of transportation operations, to reduce traffic congestion, and to enhance highway and transit safety. Systems vary in configuration and scope.

Trends in ITS Deployment

Nearly all of the major metropolitan areas in the United States have deployed ITS systems in the last decade. Most ITS systems in major metropolitan areas are coordinated through Transportation Management Centers (TMCs). ITS deployments in the 1990s were predominantly highway operations management systems. In recent years there has been a growing trend toward co-location or close linkage of TMCs with State Police or other highway patrol operations centers, and, in some cases, with city police operations centers.

ITS and Public Safety

The trend toward broadening ITS deployments to include the public safety community recognizes the need for greater coordination of multi-agency on-scene incident response, clearance, and recovery operations to enhance public safety, security, and health, and to reduce traffic congestion. Toward those ends, the USDOT formed the ITS Public Safety Program in 2000. For the EMS community, the benefits of ITS technology include improved patient care and outcomes, as well as more efficient use of the scarce resources available to EMS and other emergency health services, such as trauma centers. The ITS Public Safety Program is administered under the USDOT's ITS Joint Program Office (JPO) and the National Highway Traffic Safety Administration (NHTSA), and is coordinated with the Department of Justice and the Federal Emergency Management Administration.

For the EMS community, the benefits of ITS technology include improved patient care and outcomes, as well as more efficient use of the scarce resources available to EMS and other emergency health services, such as trauma centers.

Examples of ITS Deployments Involving EMS

Only a limited number of ITS deployments to date have involved the EMS community. Examples are discussed below.

Telemedicine Deployments

Deployments in San Antonio, Texas and Seattle, Washington, made possible through USDOT's "Model Deployments" program, involve real-time voice and video links between ambulance crews and emergency physicians—known as "tele-medicine" technologies. Through San Antonio's "Lifelink" program, about half of the city fire department's

ambulances carry portable computers, video cameras, and microphones. The video camera inside the ambulance enables emergency department and trauma center doctors to view the patient, monitor vital signs, assess the extent of injury, and determine possible treatment options while the patient is still enroute. A similar system was field-tested in the Seattle, Washington region, using a mobile web camera that transmitted to a secure web site available to emergency physicians.

"Lifelink" is integrated with the San Antonio region's "TransGuide" transportation management system. Patient data are transmitted by radio frequency to receiving antennas placed at the hubs of the fiber optic cable lines installed along roadways for reception at a TMC serving the city, state, and metropolitan transit authorities. As discussed below, mobile wireless communications technologies underpin systems currently under development.

Fleet Location and Signal Priority

Many ITS deployments include the installation of location sensors and mobile voice and data communications equipment on transit and maintenance fleets. In some cities, transponders on emergency vehicles tell traffic signals to give green-light priority to the emergency vehicle. In a few cases (e.g., Dallas, Texas), emergency vehicles are equipped with location technologies and advanced mobile data and communications systems.

Emerging Lifesaving ITS Technologies

Wireless Enhanced 9-1-1

Wireless enhanced 9-1-1 (E 9-1-1) is an emergency telephone service that provides immediate caller identification and location. E 9-1-1 automatically routes calls to the appropriate Public Safety Answering Point (PSAP) and notifies the dispatcher of the caller's location. While ninety-eight percent of the population is currently covered by E 9-1-1 for residential landline phones, wireless E 9-1-1 is not yet widely implemented anywhere in the United States. Well-publicized tragedies where rescuers have been unable to locate victims calling for help from wireless telephones have raised public awareness of the issue, although many users still are not aware of the safety limitations of their cell phone service.

The Federal Communications Commission (FCC) rules adopted in 1996 require wireless carriers to provide E 9-1-1 service. By 2005, carriers will need to provide location information for all wireless 9-1-1 calls, provided that the local PSAP is equipped to receive and use the information.

Several emergency communications and public safety organizations are actively supporting implementation of wireless E9-1-1. The USDOT, the National Emergency Number Association (NENA), and the Association of Public-Safety Communications Officials International (APCO), have initiated significant leadership and technical assistance efforts to improve cooperation between the telecommunications industry and PSAPs, and to help PSAPs to prepare to receive wireless E 9-1-1 calls.

The EMS community supports rapid implementation of wireless E 9-1-1 technology, both to provide faster emergency notification and response, and to provide the infrastructure to support more widespread application of vehicle location and incident notification technologies.

> Even as the nation works to create an infrastructure for the ACN technology already on the road, far more complex telematics systems are in development.

ACN Technologies

Automatic Collision Notification (ACN) systems already on the market (often called "Mayday systems") are intended to reduce crash notification delay, a particularly important factor in rural areas. Single-vehicle rural crashes account for about one-third of all fatal crashes. In many of these (and other) fatal incidents, the fatality occurs because of delay between the time the crash occurs and the time a call is placed to 9-1-1 (which in turn delays the arrival of medical treatment).

Telematics systems (such as General Motors' On Star, and ATX Technology's original equipment manufacturer systems) automatically transmit voice and data to a telematics response center when the driver presses a button, or when

triggered by on-board safety equipment such as an airbag or emergency tensioning safety belt. Telematics response center operators verify the accuracy of the information and then contact a PSAP to relay the emergency message.

Integration of telematics response centers with the existing PSAP infrastructure is improving, but it remains inconsistent, resulting in occasional delays in notification. Telematics calls generally are not relayed to the PSAP on 9-1-1 or other priority communication lines. This can cause delays in emergency dispatch. Improved integration should be a joint priority of both the PSAPs and the telematics industry. The EMS community believes it is in the public's best interest for emergency calls to be accurately routed to 9-1-1 centers as quickly and effectively as possible.

Input from the EMS community is urgently needed to guide further development of advanced ACN systems. The EMS community, in turn, must rapidly prepare for the introduction of advanced ACN to the marketplace.

In 2000, the USDOT and General Motors co-sponsored the National Mayday Readiness Initiative (NMRI), which brought stakeholders together to encourage effective, efficient, and seamless integration between telematics service providers (TSPs) and PSAPs. The NMRI recommendations were published in October 2000. Several of these recommendations have since been implemented by the USDOT; by the ComCARE Alliance; by the National Emergency Number Association (NENA); and by the Association of Public Safety Communications Officials (APCO).

Advanced ACN Technologies

Even as the nation works to create an infrastructure for the ACN technology already on the road, far more complex telematics systems are in development. In addition to opening a voice link when a crash occurs, advanced telematics systems will transmit data on collision severity. These crash severity data have the potential to assist responders in determining the type of EMS unit to send (basic life support or advanced life support), mode of transport (air vs. ground), and where to transport the injured (e.g., nearest local hospital or regional trauma center). Ultimately, the crash data could help doctors determine what kind of treatment may be needed, and enable them to ready an appropriate medical team (e.g., neurosurgeons, orthopedists, etc.) and other hospital resources (such as an operating room).

The advanced ACN systems currently in development rely on wireless location technology. Field tests of prototype systems have been conducted in Erie County, New York. Input from the EMS community is urgently needed to guide further development of advanced ACN systems. The EMS community, in turn, must rapidly prepare for the introduction of advanced ACN to the marketplace.

III. Analysis of Opportunities, Challenges, and Priority Needs from the "Chain of Survival" Perspective

In the EMS community, the *chain of survival* concept describes the sequence of events that must occur to ensure the best possible outcome for victims of traumatic injuries, cardiac arrest, and other time-critical life-threatening situations.

For each link in the "chain of survival" sequence, this chapter discusses

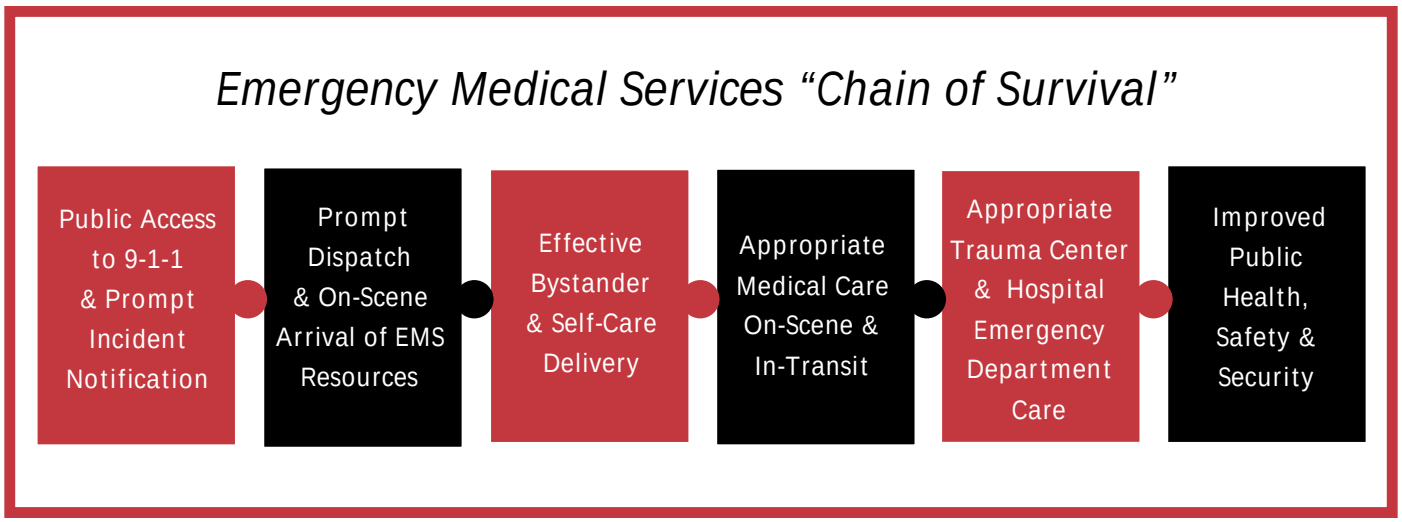
- the opportunities and concerns presented by ITS technologies;
- the implications of medical community involvement; and
- recommendations for action.

1. Public Access to 9-1-1 and Prompt Incident Notification

Opportunities for Use of New Technology to Increase Public Access to 9-1-1 and Prompt Incident Notification

Wireless E 9-1-1

Implementation of wireless E 9-1-1 will enable emergency call-takers to automatically locate the callers' cell phones. This capability also underpins advanced ACN systems. Wireless caller location technology ultimately will reduce EMS notification and response times, which in turn will reduce morbidity and mortality. Particularly compelling are the opportunities to reduce deaths and injuries from vehicular crashes and from medical emergencies—such as



acute heart attacks, strokes, and hypoglycemia.

ACN

Existing ACN technology offers additional opportunities to improve crash notification and response time, particularly in cases where the driver and passengers are rendered unconscious. When airbags deploy, a wireless voice channel opens automatically to notify operators at a private call center that the crash has taken place, and vehicle location technology (often satellite-based) enables the operators to locate the vehicle and notify a PSAP. Two companies, General Motors' On Star and ATX Technologies, currently are offering ACN systems, with two million vehicles equipped to date.

One study estimated that an ideal advanced ACN system would result in at least 1,676 fewer deaths from traffic crashes each year in the United States, which represents a reduction of approximately 6 percent.

Implications of Medical Community Involvement

Reduced Mortality

Each year more than 41,000 Americans die as a result of 6 million crashes on our nation's roadways—the equivalent of 115 each day, or one every 13 minutes. Rapid implementation of wireless E 9-1-1 can reduce this astonishing death toll.

Locating crash victims is still a major problem in this country, especially in rural areas. Rural fatalities account for 58 percent of crash-related deaths, although rural vehicle miles traveled (VMT) are only 42 percent of total VMT. For rural crashes, the average notification time (e.g., the time elapsed from the crash or the onset of an emergency until EMS is notified) is 9.6 minutes. The national average is 5.2 minutes. The average time between notification and arrival at a fatal crash scene is 11 minutes in rural areas, versus 3.4 minutes in urban areas. One study estimated that an ideal advanced ACN system would result in at least 1,676 fewer deaths from traffic crashes each year in the United States, which represents a reduction of approximately 6 percent.

Reduced Morbidity

While the opportunity to reduce the highway death toll is attractive, the potential benefits of reducing the severity of highway injuries are even more far-reaching. Traffic crashes injured 3.2 million Americans in 2000. Crash survivors often sustain multiple injuries and require long hospitalizations. Crashes cost society more than $150 billion a year and consume a greater share of the nation's health care costs than any other cause of lllness or injury. Particularly in cases of head trauma or internal injury, faster EMS response can dramatically improve a crash survivor's prognosis and reduce the collateral costs to society.

Other examples of medical emergencies where wireless location technology could greatly reduce mortality, morbidity, and collateral costs to society include acute heart attacks, strokes, and episodes of dangerously low blood sugar (hypoglycemia). Four million Americans are admitted to hospitals each year for chest pain; 600,000 for stroke; and literally millions for hypoglycemic coma. Decreased time to treatment for all of these major medical emergencies saves lives and reduces suffering significantly.

Improved Integration with Emergency Services

The early involvement of the medical and 9-1-1 communities in the development of new technologies such as telematics systems can maximize the potential benefits of call filtering and automatic location, and minimize problems related to priority input to the PSAP, and the management of nonessential data.

Recommendations

- **Implement wireless E 9-1-1 as soon as possible:** Rapid implementation of wireless E 9-1-1 is a top priority.
- **Implement Universal Wireless Coverage as soon as possible:** In rural areas, wireless telephone service often is unavailable. Rapid implementation of universal wireless coverage is necessary to provide universal public access to 9-1-1 service, and underpins advanced ACN technologies as well.
- **Fully integrate wireless E 9-1-1 technology with the existing PSAP infrastructure:** E 9-1-1 implementation must not compro-

mise the efficient operation of PSAPs or entail excessive operational or financial burdens.

- **Support PSAP readiness and provide PSAP resources for wireless E 9-1-1 implementation:** Many PSAPs lack the needed resources or technical guidance to implement wireless E 9-1-1 technology.
- **Provide priority access for wireless 9-1-1 calls:** Priority access for wireless 9-1-1 calls is needed to overcome the problem of congestion of the wireless system.
- **Fully integrate ACN technology with the existing PSAP infrastructure:** ACN technology must not compromise the efficient operation of PSAPs or place excessive operational or financial burdens. Data providers must coordinate closely with PSAPs to assure that calls are delivered on priority communication lines, that PSAPs are not required to handle unnecessary data, and that emergency messages are reliable.
- **Ensure that wireless telephones and other in-vehicle technologies do not become a dangerous driver distraction:** The National Highway Traffic Safety Administration (NHTSA) estimates that driver inattention of all sorts caused 20 to 30 percent of the 6.3 million accidents reported in 2000. Driver error remains the leading cause of crashes, cited in more than 90 percent of police crash reports. Distracted driving exploded as a major public issue in 2001, when New York State become the first to enact legislation prohibiting the use of hand-held wireless telephone while driving, and dozens of other state legislatures began to consider bills to limit cell phone use behind the wheel. Technology should be part of the solution; not part of the problem. Advanced vehicle safety systems now in various stages of development will warn drivers of dangerous situations, recommend actions, and even assume partial control of vehicles to avoid collisions. Additional research is needed to ensure that in-vehicle technology does not contribute to driver distraction.

2. Prompt Dispatch and On-Scene Arrival of EMS Resources

Opportunities for Use of New Technology to Improve Prompt Dispatch and On-Scene Arrival of EMS Resources

Automated Location Technology for Emergency Medical Vehicles

This technology enables dispatchers to monitor, in real-time, the exact location of the entire fleet of emergency vehicles and to dispatch the EMS units closest to the incident scene.

Real-time Route Guidance Systems

If linked to information systems at a transportation management center (TMC), real-time guidance systems enable the emergency vehicles to take the shortest route to the scene, while avoiding traffic congestion.

Signal Priority

Emergency vehicles equipped with transponders can be given green-light priority through intersections en route to incident scenes.

Cross-agency, Interoperable, Mobile Voice and Data Networks

These networks

- allow simultaneous dispatch of emergency vehicles from various responding agencies;
- provide all responding agencies with instant and equal access to pertinent information about the incident;
- avoid unnecessary duplication of resources while ensuring appropriate response (equipment and personnel);
- foster coordination of multi-agency response efforts; and
- provide voice and data links between the EMS crew and the physicians at the trauma center or hospital emergency department.

Advanced ACN

As noted above, advanced in-vehicle ACN systems, which are currently under development, will collect and transmit crash data, as well as location and other information. The EMS community will find crash data useful to determine the probable type and severity of injuries. This, in turn, will assist in deciding the type of

medical equipment to send to the scene and where to transport the patients. These crash data also will give the hospital or trauma center more time to prepare for appropriate emergency care.

Implications of Medical Community Involvement

As ITS technologies are rapidly introduced in the emergency dispatch environment, the medical community must be involved to ensure the seamless integration of these technologies into existing PSAP and EMS dispatch operations.

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Recommendations

- **Consider human factor requirements of PSAP dispatch operations:** The design of delivery mechanisms for advanced ACN data must specifically address the human factor requirements of PSAP dispatchers. The time needed to process a call that includes ACN data should not exceed average call-taking and dispatch time, and the process should be as automated as possible in order to minimize the chance of dispatch error. Ideally, the information necessary for dispatch decisions will be displayed automatically on the dispatcher's screen. Data delivery systems must not require dispatchers to perform non-routine tasks, such as consulting a web site.

- **Ensure the reliability of ACN data:** ACN data transmitted to PSAPs must be reliable. Some PSAPs reroute calls from unreliable sources, giving them a lower priority. Current telematics service providers use the voice link to verify that a crash or other emergency has taken place before forwarding the call to the PSAP. It is essential that other telematics providers take similar measures as they enter the market.
- **Filter ACN data sent to PSAPs:** In order to make quick dispatch decisions, PSAPs will require a limited subset of advanced ACN data. The minimum information should include the alert of crash occurrence; location of the incident; and collision severity. Automatic voice links and other information may also be desirable, and should be added based on evidence of need and benefit. All ACN crash data must be compatible with emergency medical dispatch (EMD) algorithms. Additional crash data may provide useful information for medical facilities and should be forwarded directly, according to prearranged protocols.
- **Develop standard procedures for EMS dispatch based on advanced ACN data:** In order to automate dispatch decisions that are based on crash severity data, standard procedures should be developed, including standard terminology for EMS equipment.
- **Develop information protocols, including privacy protections:** While the information needs of EMS and law enforcement overlap, the privacy of medical information and criminal justice information must be protected. The system architectures for interoperable communications systems must include information protocols that specify formats for shared information and also have appropriate firewalls to keep each agency's proprietary information out of the shared domain.
- **Provide resources to acquire information and communications equipment:** The EMS community needs resources to acquire new information and communication technology, including automated location, real-time route guidance, and interoperable, real-time, voice and data networks.
- **Use automatic notification technologies in automatic external defibrillators and implantable defibrillators:** This application of current ACN technology would enable faster and more accurate EMS medical response by notifying 9-1-1 of the location and time of cardiac arrests.

3. Effective Bystander and Self-Care Delivery

Opportunities for Use of New Technology to Improve Bystander and Self-Care Delivery

Use of Wireless Telephones, Secure Radio Networks, or ACN Systems with Automated Voice Channels

Voice interaction between a crash victim (or bystanders offering rescue assistance) and a PSAP can

- help confirm injuries;
- add key data to the triage algorithm (age of victims, treatment priority status, etc.);
- alert response teams to additional hazards or difficulties;
- enable PSAP call-takers and dispatchers to provide immediate first-aid instruction; and
- better inform EMS, trauma centers, and hospitals about the nature of the injuries.

Implications of Medical Community Involvement

Medical community involvement is needed to ensure that operators involved in voice interaction with injured patients or bystanders are able to provide appropriate emergency care instruction.

Recommendations

- **Route all 9-1-1 calls, including those originating from voice channels in Mayday or ACN systems, directly to the PSAP:** A three-way connection, including a telematics service provider, may be established in cases where public safety officials determine that information provided by the telematics service provider is of added value to dispatch decisions. It is essential for the first operator answering an emergency call to be trained in emergency medical dispatch. Telematics service providers should be permitted to perform this function only if they have received such training and are capable of delivering effective pre-arrival (first aid) instruction to callers.
- **Promote universal use of Emergency Medical Dispatch (EMD) procedures by PSAP operators:** EMD is based on a standard question-and-answer algorithm that has proven effective in reliably identifying the exact nature of the emergency and in prescribing appropriate pre-arrival (first aid) instruction.

4. Appropriate Medical Care at the Scene and in Transit to the Hospital

Opportunities for Use of New Technology to Improve Medical Care at the Scene and in Transit to the Hospital

Telemedicine

Equipping ground and air ambulances with real-time video, voice, and data connections to emergency physicians (telemedicine) can improve patient care at the scene and en route. EMTs and other medical personnel can benefit from enhanced medical direction of patient care. At the same time, emergency physicians can receive real-time data on the patient's physiological condition, enabling them to make better medical direction decisions and better preparations for the patient's care at the medical facility.

ACN Patient Data

At the vehicle owner's option, medical information about the vehicle owner and/or the owner's family might be stored in ACN systems for release in the event of a crash or other medical emergency. The data might include organ donor information, medical histories, and blood types. Measures should be taken to ensure that this information remains current and reliable.

Implications of Medical Community Involvement

Medical community involvement is necessary to ensure the seamless integration of telemedicine and ACN technologies into existing EMS operations on scene and in transit to the hospital.

Recommendations

- **Establish legal and ethical guidelines for protecting patient privacy in the telemedicine and ACN environments:** The security of voice and data communications is crucial in the telemedicine environment. Legal and ethical guidelines must be developed for videotaping patients and for transmitting patient data.

Medical community involvement is necessary to ensure the seamless integration of telemedicine and ACN technologies into existing EMS operations on scene and in transit to the hospital.

- **Establish minimum standards for data content and format:** EMS information needs to be 'bundled' with other information products so it can be disseminated readily from the scene to end-users. Public policy consensus must set minimum standards for data content and format to ensure the usefulness of EMS information, whether it is being managed by commercially marketable systems or by public service systems. Standards compatibility and confidentiality issues must be addressed.
- **Conduct research on the impact of telemedicine on the medical environment, and on its effectiveness in improving patient care:** Because telemedicine is relatively new, it is unclear how it will affect EMS procedures and which patients will benefit. Outcome-based studies of telemedicine-directed field interventions are needed.
- **Consider human factors in designing telemedicine systems:** Use of telemedicine equipment must integrate seamlessly with other tasks performed by ambulance crews and emergency physicians. Real-time patient physiological data should be seamlessly and automatically integrated into the patient's record and be made immediately available to the on-scene provider and to remote telemedicine mentors. The systems should use emerging voice recognition and heads-up display technologies to make them more user-friendly.

5. Appropriate Trauma Center and Hospital Emergency Department Care

Opportunities for Use of New Technology to Improve Trauma Center and Hospital Emergency Department Care

Interoperable Communications Networks

Linking trauma centers and hospitals into real-time regional emergency information and communications networks that provide information about incident scenes can improve patient care as well as overall public health, safety, and security. Networks would provide trauma centers and hospitals with real-time information about the nature of the incident, the number and nature of injuries, the nature of the response, involvement of hazardous materials and/or communicable disease, and so forth. The real-time information would enable the medical facility to plan for treatment by mobilizing appropriate equipment and staff.

Advanced ACN data

As previously noted, crash data, real-time patient physiological data, and patient medical history information provided by advanced ACN systems could improve trauma center and hospital emergency department care by providing notice of the probable nature and extent of injuries. Emergency physicians and trauma surgeons would be able to plan for treatment by mobilizing appropriate equipment and staff before the patients arrive. Patient medical data could either be stored in an advanced ACN system or accessed by contact information maintained in the system. Regardless of method of access, steps must be taken to ensure that patient medical data are reliable and that communication of these data complies with relevant legislation (e.g., the Health Insurance Portability and Accountability Act).

Implications of Medical Community Involvement

The medical community must be willing to develop nontraditional

partnerships and to dedicate resources in order to implement real-time data and communications networks.

Recommendations

- **Raise awareness in the medical community of the potential benefits of new information and communications technologies to emergency patient care:** The emergency medical community is largely unaware of the new information and communications technologies described in this document. A concerted effort is necessary to raise the emergency medical community's awareness of the potential for improved patient care that these technologies offer.
- **Encourage trauma centers and hospitals to participate in regional emergency response partnerships:** These partnerships should include, at a minimum, other EMS providers, transportation agencies, and law enforcement agencies. These partnerships would focus on implementation of interoperable data-exchange and communications networks.
- **Provide resources for trauma centers and hospitals to implement new information and communications technologies:** Implementation of new information and communications technologies in the hospital environment will require dedication of financial and staff resources, development of new procedures, purchase of new equipment, and training.

6. Improved Public Health, Safety and Security

Opportunities for Use of New Technology to Improve Public Health, Safety, and Security

Evaluate ITS Technologies for Effectiveness in Medical Environments

ITS technologies offer the potential for significant improvements in identifying, locating, transporting, and treating severely ill or injured patients. However, as with any widespread change being considered for emergency medicine, it is important for these new technologies to be thoroughly tested and evaluated. Emergency medical services are delivered in a challenging array of environments, often with very limited resources. It is essential for the value of new technologies to be accurately assessed and weighed against other potential system improvements to ensure that each locality is able to make informed decisions about technology investment and to develop a system design that delivers the best overall health care for the community. New technologies must leverage existing EMS infrastructure resources and enhance system performance.

Improved Information-based EMS Policy Development and Decision Making

ITS technologies and systems generate data and documentation. These data can be used to improve EMS system performance and patient care protocols. Reports generated using these data—or, at the minimum, data-sharing among lead agencies and decision-makers at the local, regional and state levels—can help state and local EMS directors and others accomplish tasks such as problem identification through pattern recognition; assessment of the effectiveness of operational processes; and resource allocation.

ITS Technologies and Homeland Security

Homeland Security is a priority concern of the nation's EMS system. The technologies and partnerships discussed in this paper within the context of improved emergency incident response and improved patient care also are the key to providing the nation with state-of-the-art public health, safety, and security.

In terrorist or other emergency incidents involving hazardous materials or communicable diseases, the voice and data networks discussed previously would provide all responders with instant, real-time notification of the presence of nuclear, biological, or chemical (NBC) materials.

The instant notification would enable responders and medical facilities to initiate appropriate procedures for containment of hazards. This protects other hospital patients and personnel, and the general public, from unnecessary exposure to the hazards.

In mass casualty incidents involving a large number of patients requiring emergency medical services, hospitals using real-time interoperable information and communication networks would be able to direct the flow of patients to more efficiently reflect the availability of the resources at regional medical facilities. If dispatchers—as well as ambulance drivers and emergency department staffs at medical facilities—had access to real time data, they could track the location of patients, the extent of their injuries, and the patient care capabilities and bed capacities of medical facilities in the region.

The medical community's approach to emergency incident response must broaden to encompass all potential hazards, from traffic crashes to bioterrorism. By implementing state-of-the-art technology and forming broad partnerships with all other responders, regional networks can be put in place to deliver prompt, effective medical response to all incidents, through more integrated, scalable, and standardized emergency operation procedures.

Implications of Medical Community Involvement

The medical community's approach to emergency incident response must broaden to encompass all potential hazards, from traffic crashes to bioterrorism. By implementing state-of-the-art technology and forming broad partnerships with all other responders, regional networks can be put in place to deliver prompt, effective medical response to all incidents, through more integrated, scalable, and standardized emergency operation procedures.

Recommendations

- **Evaluate the performance of integrated ITS systems to assess their efficiency and effectiveness for disease and injury control:** Monitor the impact of ITS technologies on EMS system performance and publish the findings to assist system administrators in making informed system design decisions.
- **Use evidence-based outcome studies to support further integration of ITS technologies into the EMS system:** Disseminate and discuss the results of system evaluations, and encourage EMS system administrators to consider integrating ITS technologies into existing EMS systems.
- **Form ongoing partnerships with all emergency responders, including emergency management agencies:** Real-time information and communications networks should include emergency management agencies.
- **Define emergency command procedures in advance, with maximum empowerment of medical directors:** In incidents involving nuclear, biological or chemical agents (NBCs), medical personnel should have the authority to order appropriate action to protect the public from exposure to those hazards (e.g., quarantine or lockdown of the site upon notification of the incident, without waiting for direction from non-medical incident commanders).
- **Encourage use of shared data to support improved information-based EMS policy development and decision making:** Encourage sharing of the data collected from ITS technologies and systems among lead agencies at the state, regional and local levels, and use of the shared data to support policy development and decision making.

IV. A Call to Action: Recommendations for the Future

Public Access to 9-1-1 and Prompt Incident Notification

- **Implement wireless E 9-1-1 as soon as possible:** Rapid implementation of wireless E 9-1-1 is a top priority.
- **Implement Universal Wireless Coverage as soon as possible:** In rural areas, wireless telephone service often is unavailable. Rapid implementation of universal wireless coverage is necessary to provide universal public access to 9-1-1 service, and underpins advanced ACN technologies as well.
- **Fully integrate wireless E 9-1-1 technology with the existing PSAP infrastructure:** E 9-1-1 implementation must not compromise the efficient operation of PSAPs or entail excessive operational or financial burdens.
- **Support PSAP readiness and provide PSAP resources for wireless E 9-1-1 implementation:** Many PSAPs lack the needed resources or technical guidance to implement wireless E 9-1-1 technology.
- **Provide priority access for wireless 9-1-1 calls:** Priority access is needed to overcome the problem of congestion of the wireless system.
- **Fully integrate ACN technology with the existing PSAP infrastructure:** ACN technology must not compromise the efficient operation of PSAPs or place excessive operational or financial burdens. Data providers must coordinate closely with PSAPs to assure that calls are delivered on priority communication lines, that PSAPs are not required to handle unnecessary data, and that emergency messages are reliable.
- **Ensure that wireless telephones and other in-vehicle technologies do not become a dangerous driver distraction:** The National Highway Traffic Safety Administration (NHTSA) estimates that driver inattention of all sorts caused 20 to 30 percent of the 6.3 million accidents reported in 2000. Driver error remains the leading cause of crashes, cited in more than 90 percent of police crash reports. Advanced vehicle safety systems now in various stages of development will warn drivers of dangerous situations, recommend actions, and even assume partial control of vehicles to avoid collisions. Additional research is needed to ensure that in-vehicle technology does not contribute to driver distraction.

Prompt Dispatch of EMS Resources and On-Scene Arrival of EMS Resources

- **Consider human factor requirements of PSAP dispatch operations:** The design of delivery mechanisms for advanced ACN data must specifically address the human factor requirements of PSAP dispatchers. The time needed to process a call that includes ACN data should not exceed average call-taking and dispatch time, and the process should be as automated as possible in order to minimize the chance of dispatch error. Ideally, the information necessary for dispatch decisions will be displayed automatically on the dispatcher's screen. Data delivery systems must not require dispatchers to perform non-routine tasks, such as consulting a web site.
- **Ensure the reliability of ACN data:** ACN data transmitted to

PSAPs must be reliable. Some PSAPs re-route calls from unreliable sources, giving them a lower priority. Current telematics service providers use the voice link to verify that a crash or other emergency has taken place before forwarding the call to the PSAP. It is essential that other telematics providers take similar measures as they enter the market.

- **Filter ACN data sent to PSAPs:** In order to make quick dispatch decisions, PSAPs will require a limited subset of advanced ACN data. The minimum information should include the alert of crash occurrence; location of the incident; and collision severity. Automatic voice links and other information may also be desirable, and should be added based on evidence of need and benefit. All ACN crash data must be compatible with emergency medical dispatch (EMD) algorithms. Additional crash data may provide useful information for medical facilities and should be forwarded directly, according to prearranged protocols.
- **Develop standard procedures for EMS dispatch based on advanced ACN data:** In order to automate dispatch decisions that are based on crash severity data, standard procedures should be developed, including standard terminology for EMS equipment.
- **Develop information protocols, including privacy protections:** While the information needs of EMS and law enforcement overlap, the privacy of medical information and criminal justice information must be protected. The system architectures for interoperable communications systems must include information protocols that specify formats for shared information and also have appropriate firewalls to keep each agency's proprietary information out of the shared domain.
- **Provide resources to acquire information and communications equipment:** The EMS community needs resources to acquire new information and communication technology, including automated location, real-time route guidance, and interoperable, real-time, voice and data networks.
- **Use automatic notification technologies in automatic external defibrillators and implantable defibrillators:** This application of current ACN technology would enable faster and more accurate EMS medical response by notifying 9-1-1 of the location and time of cardiac arrests.

Effective Bystander and Self Care Delivery

- **Route all 9-1-1 calls, including those originating from voice channels in Mayday or ACN systems, directly to the PSAP:** A three-way connection, including a telematics service provider, may be established in cases where public safety officials determine that information provided by the telematics service provider is of added value to dispatch decisions. It is essential for the first operator answering an emergency call to be trained in emergency medical dispatch. Telematics service providers should be permitted to perform this function only if they have received such training and are capable of delivering effective pre-arrival (first aid) instruction to callers.
- **Promote universal use of Emergency Medical Dispatch (EMD) procedures by PSAP operators:** EMD is based on a standard question-and-answer algorithm that has proven effective in reliably identifying the exact nature of the emergency and in prescribing appropriate pre-arrival (first aid) instruction.

Appropriate Medical Care On-Scene and in Transit

- **Establish legal and ethical guidelines for protecting patient privacy in the telemedicine and ACN environments:** The security of voice and data communications is crucial in the telemedicine environment. Legal and ethical guidelines must be developed for videotaping patients and for transmitting patient data.
- **Establish minimum standards for data content and format:** EMS information needs to be 'bundled' with other information products so it can be disseminated readily from the scene to end-users. Public policy consensus must set minimum standards for data content and format to ensure the usefulness of EMS information, whether it is being managed by commercially marketable systems or by

public service systems. Standards compatibility and confidentiality issues must be addressed.

- **Conduct research on the impact of telemedicine on the medical environment, and on its effectiveness in improving patient care:** Because telemedicine is relatively new, it is unclear how it will affect EMS procedures and which patients will benefit. Outcome-based studies of telemedicine-directed field interventions are needed.
- **Consider human factors in designing telemedicine systems:** Use of telemedicine equipment must integrate seamlessly with other tasks performed by ambulance crews and emergency department physicians. Real-time patient physiological data should be seamlessly and automatically integrated into the patient's record and be made immediately available to the on-scene provider and to remote telemedicine mentors. The systems should use emerging voice recognition and heads-up display technologies to make them more user-friendly.

Appropriate Trauma Center and Hospital Emergency Department Care

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Improved Public Health, Safety and Security

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- **Encourage use of shared data to support improved information-based EMS policy development and decision making**: Encourage sharing of the data collected from ITS technologies and systems among lead agencies at the state, regional and local levels, and use of the shared data to support policy development and decision making.

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